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R&D

Research & Development

Salaries and all-1989 *R&D* industry profile

News of importance to people who work in *R&D*

Transputer arrays for parallel processing

R&D

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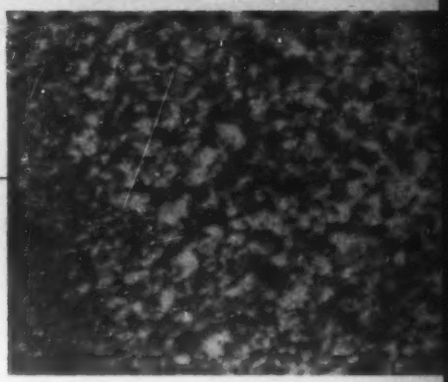

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HTS, AIDS research should get top priority for funds, scientists say

AN EXCLUSIVE *R&D* magazine survey shows that scientists and R&D managers favor giving top priority for Federal research dollars to high-temperature superconductivity (HTS) and AIDS.

The survey of 1,000 scientists was designed to provide guidance to Congress and the White House on science and technology policy. It revealed that:

- A wide majority (73%) of respondents want overall Federal funding for R&D increased—by a median amount of 10%.
- A clear majority (56%) would slash defense-related R&D. Taking all responses into account, scientists favor trimming defense R&D by a median of 5%.

"Too much defense-related expenditure saps R&D talent away from private-sector needs," said one materials scientist.

- An overwhelming 86% favor increasing civilian-related research—by a median of 10%, taking all responses into account.
- Scientists believe that any increase in Federal R&D should be paid for by cutting defense spending (66%), increasing Federal taxes on cigarets and liquor (63%), and boosting R&D tax credits to the private sector (60%). Totals exceed 100% because respondents were asked to list three choices. (See chart on following page.)

Paying for big science

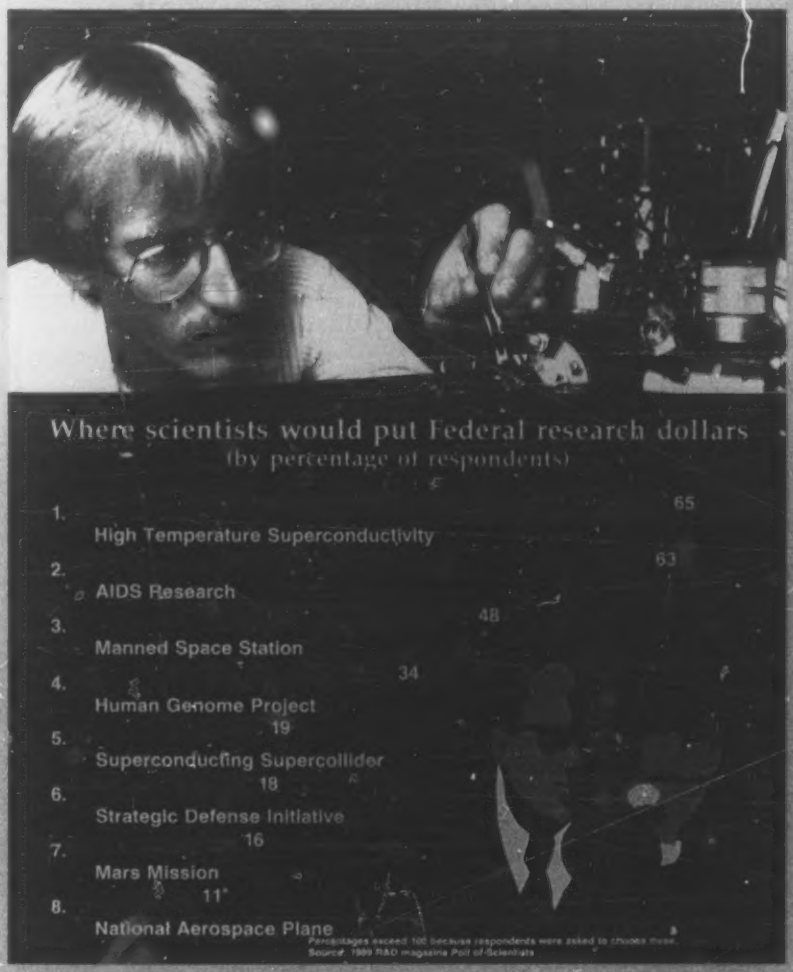
Asked to list the three most important science programs in order of priority, scientists singled out research on high-T_c superconductivity (65%) and AIDS (63%) for Federal funding priority. The manned space station was listed by 43% of respondents (see chart).

One respondent criticized the "megaprojects" approach to research in favor of individual, peer-reviewed projects. "The trend toward 'big science' already is decreasing the quality and quantity of science" in America, said researcher Doug Frank, a university-based analytical chemist in Ohio.

In line with their general lack of support for defense-related R&D—only 19% favored increasing defense R&D while 25% said it should remain the same—respondents gave the Strategic Defense Initiative only moderate support (18%). As one analytical chemist employed by the government put it: "With SDI, funds and person-hours are diverted from more-practical projects."

One item that was not on the list—cleaning up the environment, particularly of toxic wastes—drew considerable response anyway. "I'm *very* disappointed that environment was not included" among the choices, said Michelle Herrera, a drug-company chemist in Massachusetts. "Shame on you!"

The survey was mailed in January to a randomly selected sample of 1,000 scientists who attended the 1988 Pittsburgh Conference. More than 260 valid responses were received, making the results projectable at the 95% confidence level, with a


Where scientists would put Federal research dollars
(by percentage of respondents)
1. High Temperature Superconductivity 65
2. AIDS Research 63
3. Manned Space Station 48
4. Human Genome Project 34
5. Superconducting Supercollider 19
6. Strategic Defense Initiative 18
7. Mars Mission 16
8. National Aerospace Plane 11
Percentages exceed 100 because respondents were asked to choose three.
Source: 1989 R&D magazine Poll of Scientists

High-temperature superconductivity and AIDS research topped the list of science "megaprojects" worthy of high priority for Federal funding, an exclusive R&D magazine survey of Pittsburgh Conference attendees shows. (Photo: Kevex Instruments)

statistical margin of error of ±6%.

Respondents were asked to give the single most important R&D-related issue they face. An electrical engineer whose company makes DNA sequencers said, "Getting corporations to spend money on R&D rather than on M&A" (mergers and acquisitions). Another respondent, Dane Karr, senior scientist with a Pennsylvania plastics company, exclaimed, "Corporate takeovers! What a threat!"

Short-term priorities

The lack of long-term corporate thinking bothered a number of those polled. "The fact that short-term performance takes priority over long-range plans and projects makes a long-term strategic approach to a technical market difficult or impossible," said Dr. James Shoolery, an NMR applications chemist with Varian Instrument Div., Palo Alto, CA, and *R&D*'s 1983 Scientist of the Year.

Jay Russell, a chemist with Chembond Corp., Springfield, OR, agreed that "the need for immediate results from research projects" is a major problem. One analytical chemist said that, at his firm, "research is something a few people dabble in to keep Wall Street happy but is not taken seriously by the company." An organic chemist said his company "has been run by 'bottom liners' with no foresight" who are "only concerned with the next quarter."

Another scientist bemoaned the "lack of long vision and commitment to extended research," while a chemicals researcher decried the "dependence of the R&D budget on sales." Yet another, in the energy-products area, criticized "restrictions on the kind of 'research' that can be pursued—benefits must be immediately evident."

Others complained that cutbacks in R&D budgets often prevented them from buying the latest equipment or hiring enough staff. An aerospace industry researcher noted that "competition has reduced corporate R&D spending in order to increase manufacturing improvement spending."

David Burge, an analytical instruments consultant in California, said his problem was "finding a way to use a variety of technologies in a small company which cannot afford to support all of the needed talent."

Tied up in red tape

Many of those in industry blame Big Government for some of their problems. A researcher at a New Jersey drug company said he sees "excessive legal requirements for documentation" of data by regulatory authorities.

The director of analytical research for a New Jersey drugmaker was distressed over the "incompetence" of personnel at Federal agencies such as the Food & Drug Administration. "Sometimes they don't even understand the terminology of the drugs they're supposed to be regulating," he said.

Overregulation may be hurting U.S. industrial competitiveness, said one chemist who makes resins for coatings and adhesives. The solution, he said, will require "finding a way to obtain cooperation between related U.S. industries without getting into trouble with the government," presumably over antitrust laws. "This would improve our ability to compete internationally."

But not all red tape comes from Washington, as Ciba-Geigy's Michael K. Pastorcich noted in describing the general problem he sees of "meeting competition (foreign and domestic) within the bureaucratic structure of a large corporation."

People problems

Many respondents echoed the concern of Dr. Terry Ramus, project manager for a California chemicals firm, who sees "insufficient talent available." Said Ramus, "More emphasis has to be placed on developing future researchers."

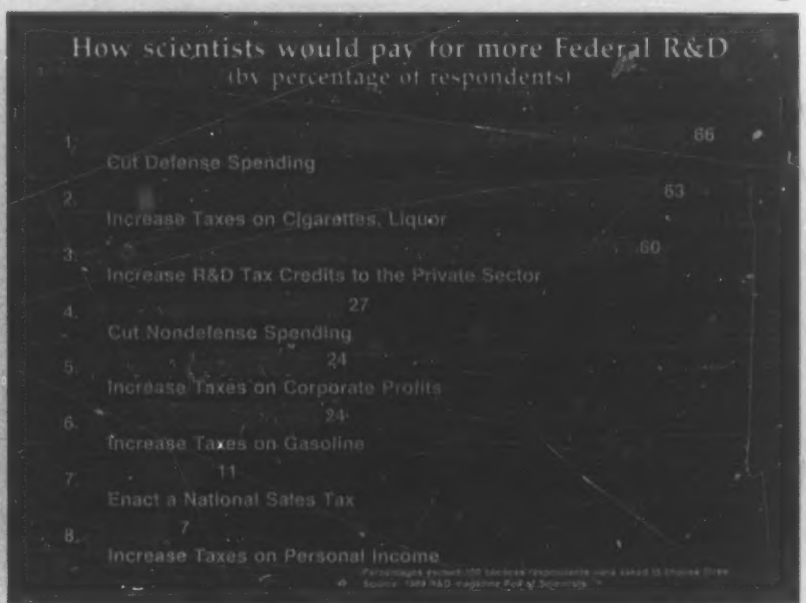
Materials scientist Rick Beaver, project manager for a Pittsburgh-area R&D firm, also complained about a "lack of qualified scientists," as did government R&D project manager Paul Mogan of the "lack of qualified civil-service manpower." Dr. Jan St. Pyrek, who runs the mass spectroscopy lab at Rice Univ. in Houston, worries about the "lack of students devoted to science."

Ted Westlake, a chemist with a Louisiana petrochemical company, added that "universities are teaching students to be teachers, not industrial researchers."

A few respondents are worried about workplace conditions. John Robbins, group leader for R&D analytical services at Hershey Foods Corp., Hershey, PA, said he is concerned about the "isolation of R&D personnel" and the "prejudice and lack of understanding by nontechnical associates and peers" of their work. "I want to see more technical people in the ranks of executives," he said.

An engineer whose company makes hemodialysis devices is annoyed by "the impossibility" of R&D people getting into management, which he said is "occupied by sales and marketing-educated 'experts.'"

Martin T. Scott, an environmental chemist in Delaware, may have put his finger on the biggest problem of all, the "lack of knowledge by the public and politicians of what is involved in research."—*Robert Cassidy*


How scientists would pay for more Federal R&D
(by percentage of respondents)
1. Cut Defense Spending 66
2. Increase Taxes on Cigarettes, Liquor 63
3. Increase R&D Tax Credits to the Private Sector 60
4. Cut Nondefense Spending 27
5. Increase Taxes on Corporate Profits 24
6. Increase Taxes on Gasoline 24
7. Enact a National Sales Tax 11
8. Increase Taxes on Personal Income 7

Survey respondents clearly favor cutting defense spending, boosting "sin" taxes, and providing more R&D tax credits as the way to finance an increase in Federal R&D.

Salaries Are Up Substantially For People Who Work in R&D

R&D magazine's annual profile of the industry shows that median income increased more than 9% in the past year.

By ***Robert R. Jones****, Editor, R&D magazine*

OVER RECENT YEARS, the salary picture for workers in research, development, and quality assurance has varied regularly from bright to gloomy and back. This year it looks brighter than it has in a long time.

Median income for all workers in this industry is up a significant 9.25% this year, which—after allowing for inflation—means 4% in real gain!

As a result, gross salary income for workers in this industry now exceeds $28.45 billion/yr in the U.S. alone.

These and other conclusions reported in this article are based on the responses of more than 1,700 readers of *R&D* magazine.

Salary spread widens

As was mentioned in last year's profile of the industry, the once-classical Gaussian distribution of salaries in the R&D industry has become distorted.

Despite the increasing distortions, for the four prior years the peak (representing the largest number of workers within a salary range) had stayed in the same location—the $40,000 through $44,999 range.

This year the most-populous salary range and the peak of the curve have moved up two positions to the $50,000 through $54,999 range.

The curve has not moved in its entirety. There still are workers in R&D who are earning less than $15,000/yr and quite a few in the $15,000 through $19,999 and $20,000 through $24,999 ranges.

Thus, the curve has broadened to span an income range of $70,000/yr. It has become more shallow, with this result:

In 1986, 60.8% of workers in research, development, and quality assurance who responded to our survey reported salaries in the ranges from $35,000 through $59,999.

Last year that figure had dropped to 58.7, a decline of 3.5%. This year 57.3% of R&D workers are in that span after a further drop of 5.76%.

A lower peak

The salaries of many workers who were in the $35,000 through $59,999 range have moved up. Inflation has been a small factor, but the normal rewards in this industry for age and experience were larger factors. At the same time, these individuals have not been fully replaced in the lower ranges and, thus, the peak is lower.

Specifically, the portion of respondents in the salary ranges above $59,999/yr is more than 2.5 times as large as it was two years ago. It has increased from 8.7% in 1986 to 14.4% in 1987 and to 22.1% last year.

After adjusting last year's salary increases for inflation, 44.2% of workers in R&D had an increase in income. This is the lowest such figure since 1984.

An accompanying table (facing page) shows the distribution and size ranges of salary increases for workers in R&D for the years from 1984.

With a larger portion of R&D workers in the higher salary ranges this year, the median salaries for workers in all disciplines have moved upward. In fact, this year's median salary, with the 9.25% rise from last year mentioned earlier, reverses a downward trend. Previous median salary gains have been 1985 6.3%, 1986 3.2%, 1987 4.3%, and 1988 0.4%.

One result of the higher salary ranges is that no discipline's workers suffered a loss in median income; the first time in several years that there have been no losses.

Data from this year's survey place the median salary for ceramists four notches higher than it was last year, and in line with those of preceding years, suggesting that last year's ranking could have reflected an error.

It may seem to industrial engineers that there is something to the old line about the rich getting richer.

Aeronautical engineers, who have ranked first both this year and last in median annual salary, made a gain of 8.7% this year to $57,500 while the industrial engineers, last in the rankings both years, gained 1.7% to $38,125/yr.

A $20,000 span

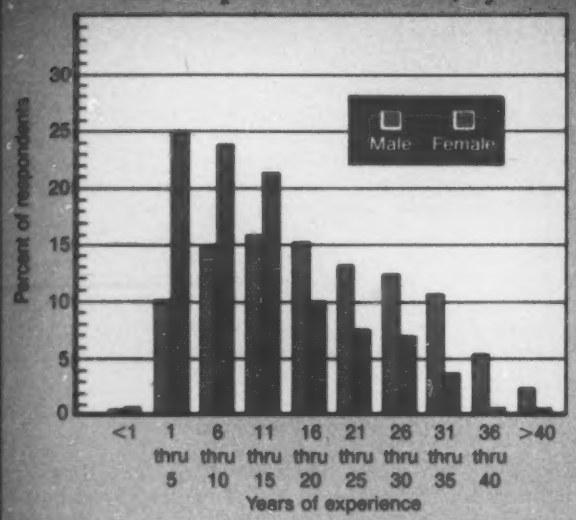
Thus the span from low to high median increased from $15,417 last year to $19,375 this year. A result of this is that the typical aeronautical engineer's salary now is more than 150% as large as the typical industrial engineer's.

For workers in research, development, and quality assurance, there is a strong correlation between salary and years of experience. This is demonstrated in the chart of median years of experience in each salary range.

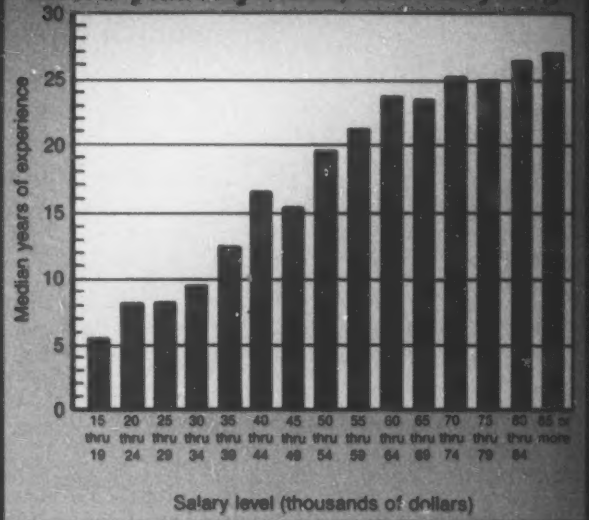
In this chart there are only three small exceptions to total correlation.

The respondents who reported a

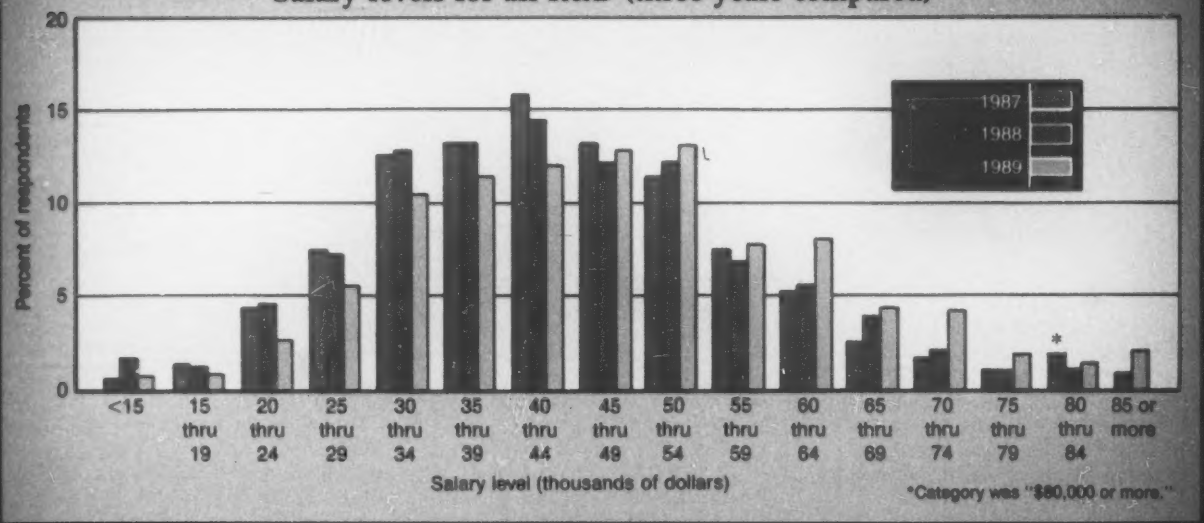
Years of experience—all R&D, by sex



Median years' experience, each salary range



Salary levels for all R&D (three years compared)



*Category was "$80,000 or more."

Increases in rate of pay*

Amount of increase	1989	1988	1987	1986	1985	1984
	Percent of respondents					
None	9.3	14.5	16.5	11.3	9.3	16.3
Less than 2%	5.3	6.3	4.3	3.6	2.9	2.1
2 through 5%	54.8	49.8	39.2	37.1	36.6	26.9
6 through 9%	22.2	21.7	30.8	36.3	37.6	38.9
10 through 13%	5.6	4.7	6.0	8.3	10.1	11.5
14% or more	2.7	3.0	3.2	3.3	3.6	4.4
Ahead of inflation	44.2	46.0	79.2	60.1	63.3	54.8

*Granted in preceding year for year shown.

Discipline rankings by median salaries

Rank 1989	Rank 1988	Discipline	Median salary 1989	Median salary 1988	Percent increase
1	1	Aero. Engr.	$57,500	$52,917	8.7
2	2	Metallurgist	52,205	49,375	5.7
3	4	Physicist	51,087	47,955	6.5
4	3	Geologist	50,500	48,750	3.6
4	8	Ceramist	50,500	43,750	15.4
6	5	Elec. Engr.	50,185	45,476	10.3
7	6	Chem. Engr.	49,100	45,109	8.8
8	7	Mech. Engr.	48,900	44,828	9.1
9	9	Chemist	45,243	42,113	7.4
10	11	Biologist	43,846	40,625	7.9
11	10	Mathematician	42,500	41,250	3.0
12	12	Indust. Engr.	38,125	37,500	1.7

When salaries are keyed to experience, women often come up short.

salary of $85,000/yr or more also show the highest median years of experience, at 26.9. Close behind, workers reporting salaries of $80,000 through $84,999/yr have the second-highest experience median at 26.3.

Here is where sex differences begin to appear in salaries. For numerous good reasons, it is difficult for a woman to have as many years of experience in research and development or quality assurance as a man may have.

The situation is displayed in the years of experience by sex chart. It shows that nearly half of the women respondents have less than 11 years' experience. Only a fourth of the men have less than 11 years' experience.

Thus 50% of the women and 75% of the men are in the more-experience-means-more-pay category.

It can hardly be surprising, then, that 48.1% of the female respondents to this survey are in salary brackets below $35,000/yr, while only 17.6% of the men are in that range.

At the upper end

At the upper salary end, generally populated by individuals with many years of experience, 8.2% of the female respondents are getting

The educational profile of the technical professional in R&D environments

By George A. McGinn

HELPING to maintain the technical vitality of the professional employe is one of the primary considerations of an industrial education support program.

However, comparisons of current educational profiles of professionals in high technology environments are not commonly available.

One of the few complete published profiles available is contained in *Organizing for Innovation* (1), which gives a complete view of the Bell Telephone Laboratory in the mid-1960s.

The U.S. Dept. of Labor Bureau of Labor Statistics (BLS) publishes material related to the training needed to enter various occupations. As an example, data from BLS Bulletin 2251 (2) show that 63% of the work force of electrical/electronic engineers needs four or more years of college to qualify for their jobs.

For many years, *Research & Development* magazine has published an annual survey containing educational breakouts in addition to salary data for a variety of engineering and scientific occupations (3).

From those surveys, the upper chart at right shows the educational profile averaged over the years 1983 through 1986 for three engineering occupations. As one might expect, the profile is shifted significantiy toward a more-educated work force within the high technology segments surveyed by *R&D*.

For example, in the BLS study, only 58% of the mechanical engineers have four or more years of college as compared to 84% in *R&D*'s study.

Using data from the IBM Endicott site (4), the educational level was collected for technical professionals in two 10-yr service ranges 25 yr apart. In addition, a projection for 25 yr from now is presented at lower left.

The Endicott facility, IBM's oldest site, is typical of high technology and manufacturing facilities in this country over the past 25 yr.

The most striking feature is the shift from engineers not holding degrees to those with BS degrees. MS and PhD holders also have increased significantly over the same period.

The projection shows the nondegree component, which shrank to a seventh of its size over the past 25 yr, becoming almost negligible.

The bachelor degree component, which grew by 300% in the first 25 yr, will decline as a percentage in the second. The MS component will continue to grow and become the most-common one, although the percentage of growth will be less in the second 25 yr.

Finally, the PhD component will continue to grow at the rate that it has during the past 25 yr, reaching 20% of the total professional staff.

Technical vitality

Three major parameters are related to the technical education needed to maintain vitality: educational level, total years of service, and specific occupation of the individual.

For an occupational group, the education and service parameters can be displayed by means of the 3-D bar chart shown. This format displays the total target population on a single chart.

Each bar represents the number of individuals with a specific education level and a given length of service. The left-hand column shows the education levels for all service years.

The top row shows the total of individuals in each service interval. Finally, the extreme upper-left-hand bar shows total population.

This allows easy identification of specific groups that might need emphasis. A common influence on the educational breakout is the historical hiring pattern within an industry or company.

From the previous figure, we see that the ratio of education levels for new hires has changed significantly over the past 25 yr. Thus the specific time frame of a hiring variation can influence the total education mix in a given group.

In the third figure, the number of employes with 10 to 19 yr of service is low. This corresponds to a time when bachelor degrees dominated the hiring pattern.

Thus, the total population could be expected to have a lower percentage of bachelor degree holders than if a constant hiring pattern had been maintained.

For general planning purposes, assumptions can be made about the average total technical vitality education. For example, we could assume that those with less than 10 years' total service will require a minimum of 20 hr/yr while those with more than 10 yr will need an average of 40 hr.

Given these assumptions and the population shown in the third figure, a total of 13,960 hr of education could be expected. The breakout by education level also can influence the type and potential source of the vitality education needed.

As an example, for the data in the third figure, 20% of the total education is for engineers holding MS

$60,000/yr or more while 23.7% of the males fit into that range.

In the sidebar below, George A. McGinn looks at the educational profiles of technical professionals.

In the second part of this industry survey we will look at how the level of education has affected the salaries of the respondents. We also will see how well an investment in additional years of training can pay dividends in increased income over the years of an individual's career.

Charts will show comparisons for raise, salary range, years with present employer, level of education, years of experience, and age of respondents for 12 disciplines.

Finally, details on median salaries by workplace will suggest benefits or lack thereof for workers in government, university, or industry. **R&D**

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High **371** Medium **373** Low **375**

or PhD degrees. The level of material needed for their vitality would differ significantly from the level needed for those engineers holding bachelor degrees (39%).

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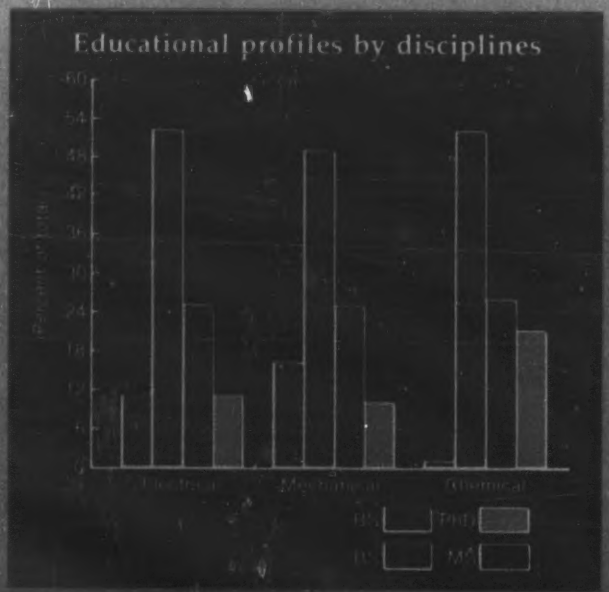

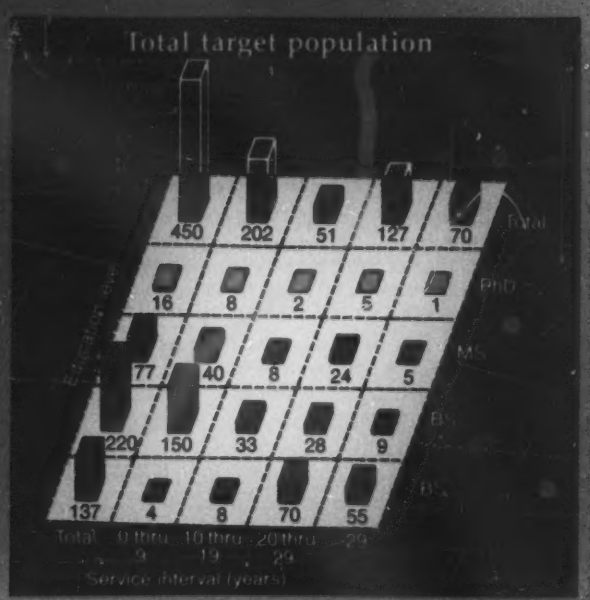

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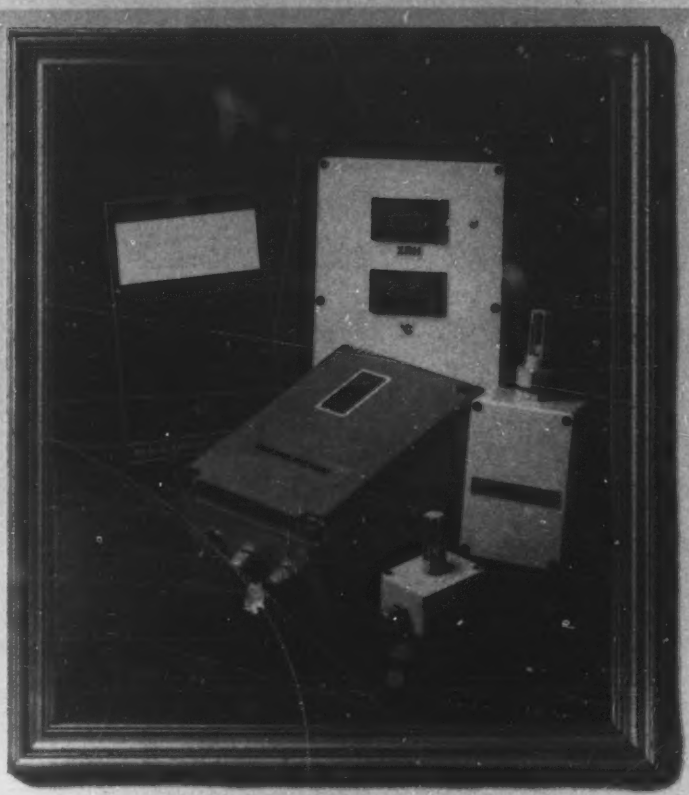

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